Space Weather Technical Forecast

Issued on Monday, 24 January 2022 at 12:52 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/Minor Geomagnetic storms days 1-3 (24th-26th). Active fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low in the past 24 hours, with a C1-flare observed from a far-sided region that has recently rotated over the northeast limb and onto the Earth-side as a Bxo/Beta. This will need further analysis as it rotates into a better view. A further unnumbered Bxo/beta region developed in the north-centre disc, but remains small and simple. AR2934 Hsx/Alpha remains a mature, stable and inactive region. No Earth-directed CMEs were observed in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, eased from slightly elevated, near 400 km/s to just over 300km/s. The solar wind density gradually increased from average or below average levels to around 10-16 ppcc. The interplanetary magnetic field (IMF) strength, Bt, was weak but peaked at just over 6nT at 24/1100 UTC. The north-south component ranged of -4 to +5nT. The phi angle was mostly negative (towards the Sun), with brief rotations to positive (away). Geomagnetic activity was Quiet throughout.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at Background levels. The high energy electron flux (greater than 2MeV), was mainly at High levels, with a peak value of 6130pfu at 23/1620UTC. Electron fluence persisted above the 1e8 Active threshold throughout, with a slight rising trend, with fluence at 24/0000UTC measured at 2.38e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Low to Very Low, with three small and simple sunspots on the Earth-facing side of the disc, giving a chance of further C-class flares.

Solar Wind / Geomagnetic Activity: There are several glancing CME arrivals possible in the forecast period, through to day 3 (26th). The fast wind of CH46 is also expected to arrive, most probably day 2 (25th) but with some notable uncertainty. Until the arrival of this fast wind, or any CMEs, background slow wind conditions will ensure Quiet geomagnetic activity with only a slight chance of Unsettled. Any enhancements will bring a risk of Active intervals, with a chance of G1/Minor Geomagnetic storms.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is forecast to remain at Background levels. The high energy electron flux (greater than 2MeV) is expected to continue to reach High flux levels at the diurnal peak day 1 and perhaps day 2 (24th and 25th). However, the forecast carries low confidence, with the potential for drop out from CME glances. A drop out in values is then likely from the arrival of the fast wind of CH46. The 24-hour fluence is forecast to persist above the Active (1e8 integrated pfu) threshold initially, and early day 2 (25th). This likely dropping below the Active threshold day 3 (26th) but with a chance of remaining above.

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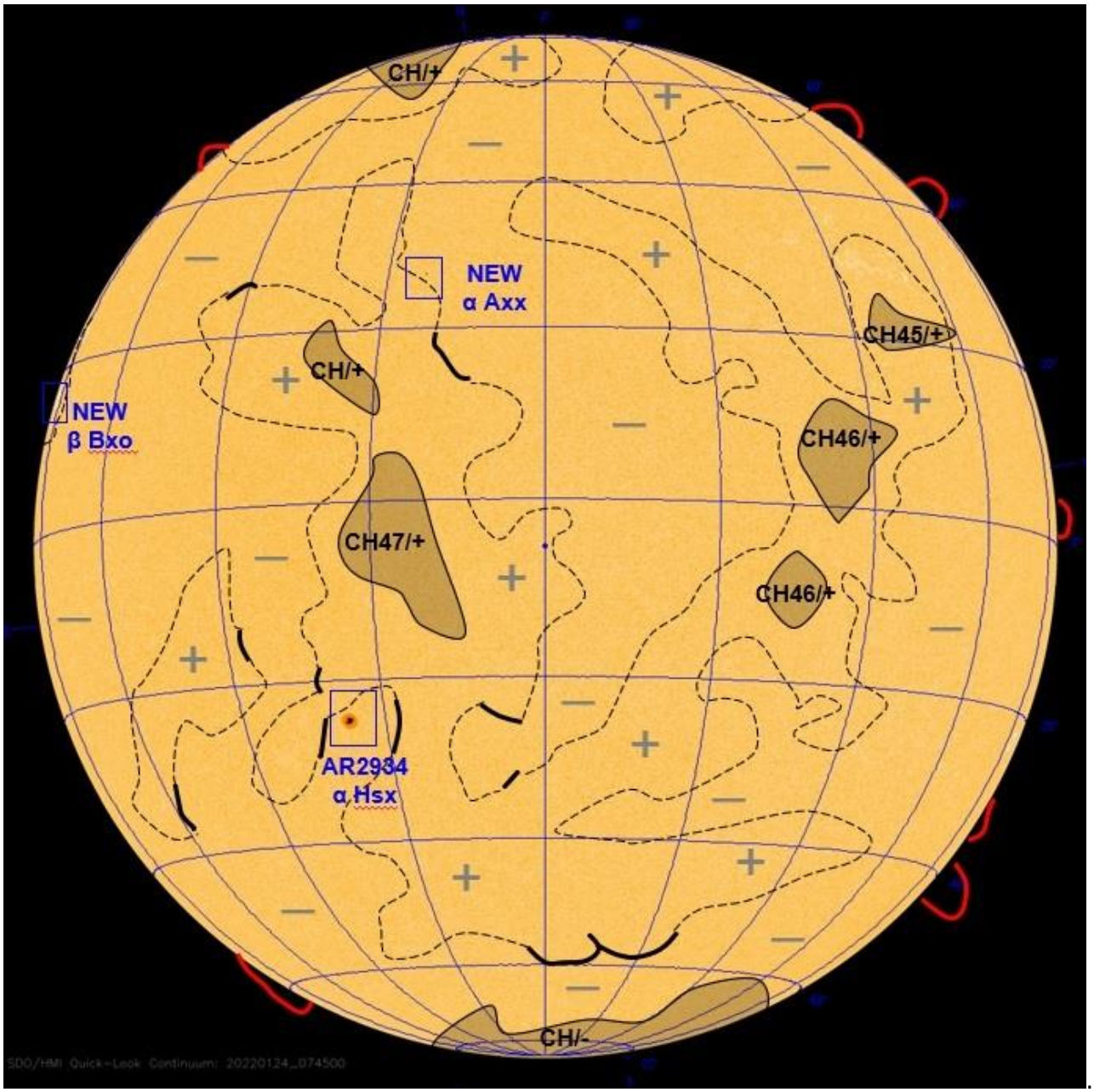
Figure 1. Solar Analysis Valid 24/0800.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are several CMEs anticipated to glance Earth in the forecast period, with forecast arrivals up to and including the middle of the UTC week.

A CME from a filament eruption on 19 January should have reached 1AU in the last 24 hours, but has now likely missed. A second CME, associated with a southwest quadrant filament eruption (possibly triggered by the M5 flare from Ex-AR2929 on the 20th), is modelled as potentially brushing Earth on day 1 (24th). Thirdly, a further filament eruption and subsequent CME from near the southeastern limb on the 21st, could also possibly brush past Earth on day one, albeit with lower confidence in arrival. Fourthly and finally, a further filament lift off the 22nd shows a possible glance late on day 2 or early day 3 (25th or 26th).

Any of these arrivals have the potential to combine with a forthcoming fast wind arrivals, from either CH45, which is now hard to distinguish, or more likely from CH46. STEREO A PLASTIC data has a clear enhancement, perhaps from the latter of these holes, although the bulk of the strong winds appear to not occur until late in the trace, and hence map to an arrival later day 2 or early day 3 at Earth. Whilst the speeds observed by the spacecraft would suggest an imminent arrival on day 1 (24th) given the coronal holes current location. Due to this mismatch, it is possible that the fast wind observed by STEREO A is due to CH47, although this seems to early, with arrival considered most likely at Earth day 5 (28th). Overall, day 2 (25th) currently appears most likely for the arrival of the fast wind of CH46, but with significant uncertainty.

Given the number CME features, and the uncertainty around the coronal hole arrival times, confidence in this forecast period is low. Overall, however, geomagnetic activity is anticipated to be initially Quiet with only isolated Unsettled intervals possible but likely to rise to Active, with a chance of G1/Minor Storm intervals from either the coronal hole fast wind transition, or any CMEs that arrive, especially if they are co-incident.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	30	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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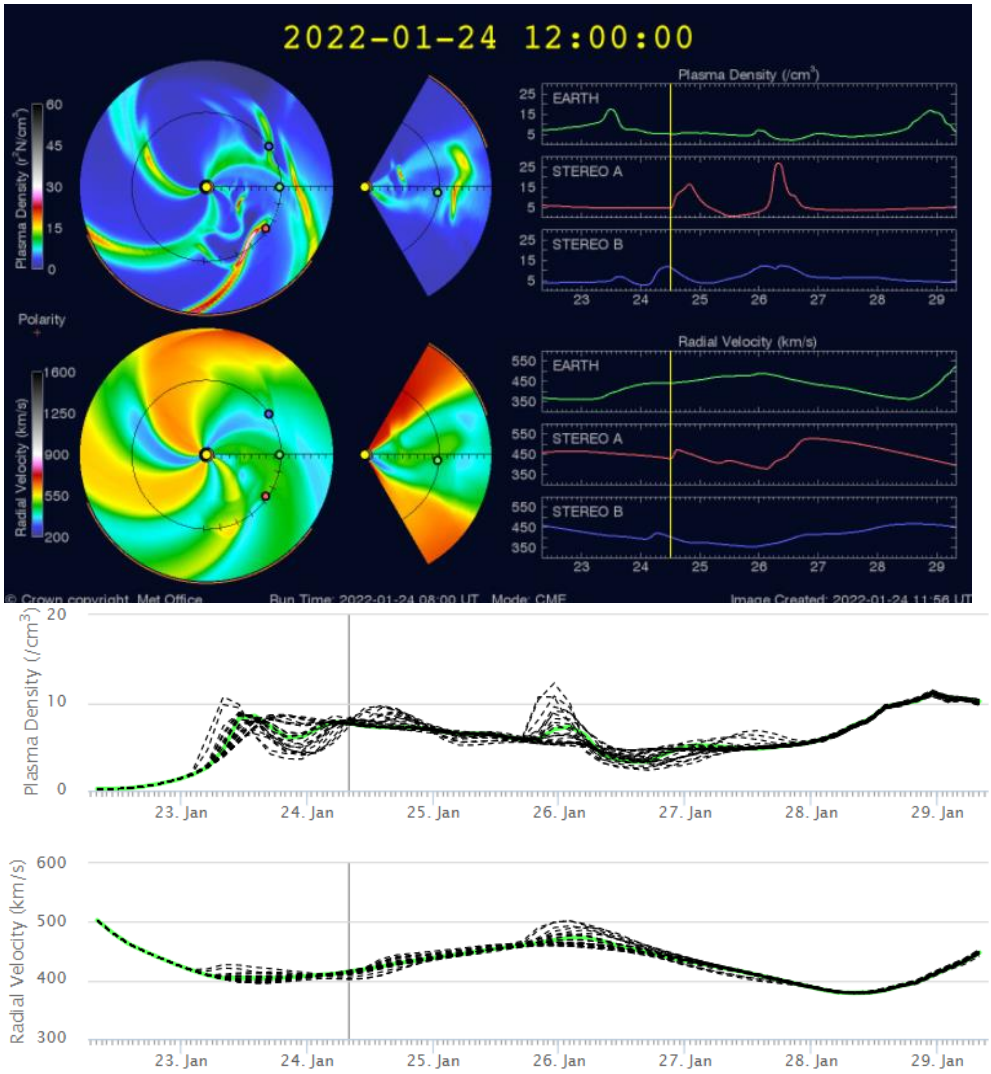
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
19/1837	Partial	Filament	S16 W017	288	23/1500UTC, now overdue	Assumed missed
20/1642	Partial	Filament	S02 W059	478	24/1200UTC	Most likely ahead of Earth
21/0900	Partial	Filament	S23 E061	601	24/1200UTC	Possible glance
22/0630	Partial	Filament	N15 E020	400	26/0001UTC	Possible glance

Figure 2: MOSWOC Enlil and Ensemble



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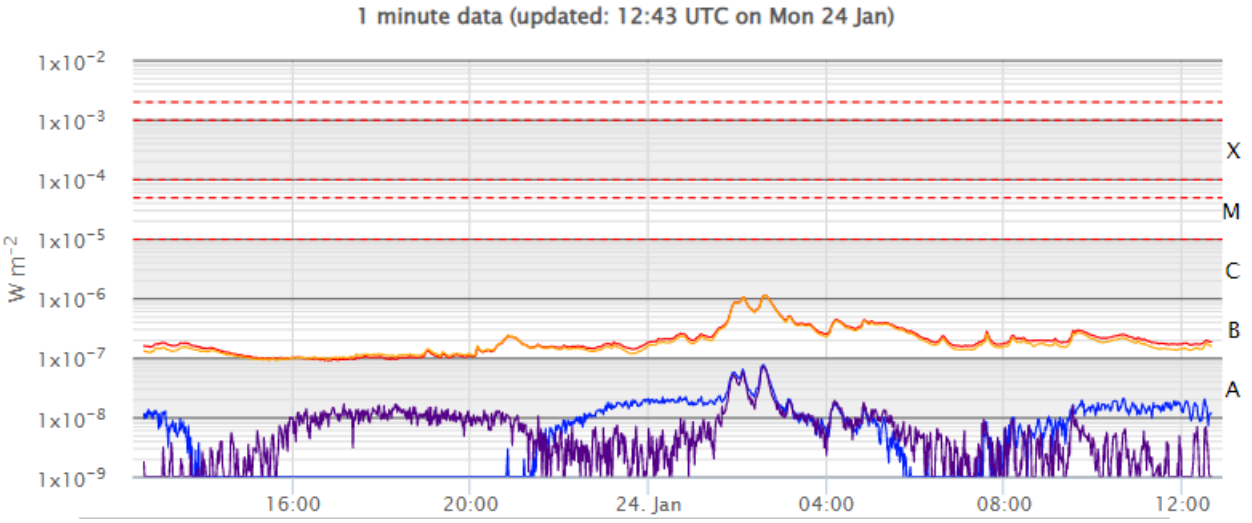
Radio Blackouts - X-Ray Flares:

There are currently three sunspot containing active regions on the visible disc, however these are all currently small and simple. AR2934 is a stable and mature Hsx/alpha region, and remains inactive as it traverses across the southern disc. The other two regions are both unnumbered, including a newly developed Bxo/beta spot just east of the northern central disc and a further far-sided region that has recently rotated onto the Earth-side. This latter region is currently classified as a Bxo/beta, but will need further assessment as it rotates into view, and was also the source of the sole C-flare in the last 24 hours.

Without any further development Low to Very Low activity is expected during this period, with a chance of further C-flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	1	1	1	1
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES 16/17 X-ray Flux



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at background levels. No solar radiation storms are expected in the period with only a few simple and inactive sunspots on the Earth-facing side of the Sun.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux, as measured by GOES-16 at GEO, has remained on a steady oscillation within generally High levels over the past 24 hours, although peak values are now declining. A more dramatic drop off in observed values is expected from any fast wind or CME arrivals, which are possible throughout the period, although confidence is low for both when these will occur and their strength. Flux levels are most likely to fall to background to moderate values day 3 (26th) but with notable uncertainty.

The associated fluence is expected to remain Active until at least early day 2 (25th), but then likely to fall below the Active threshold by day 3 (26th) but with a chance of remaining above. This is above the expectations of REFM, which is currently giving poor guidance, although a decreasing trend is expected even in the absence of any CME or fast wind arrivals.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	99	40	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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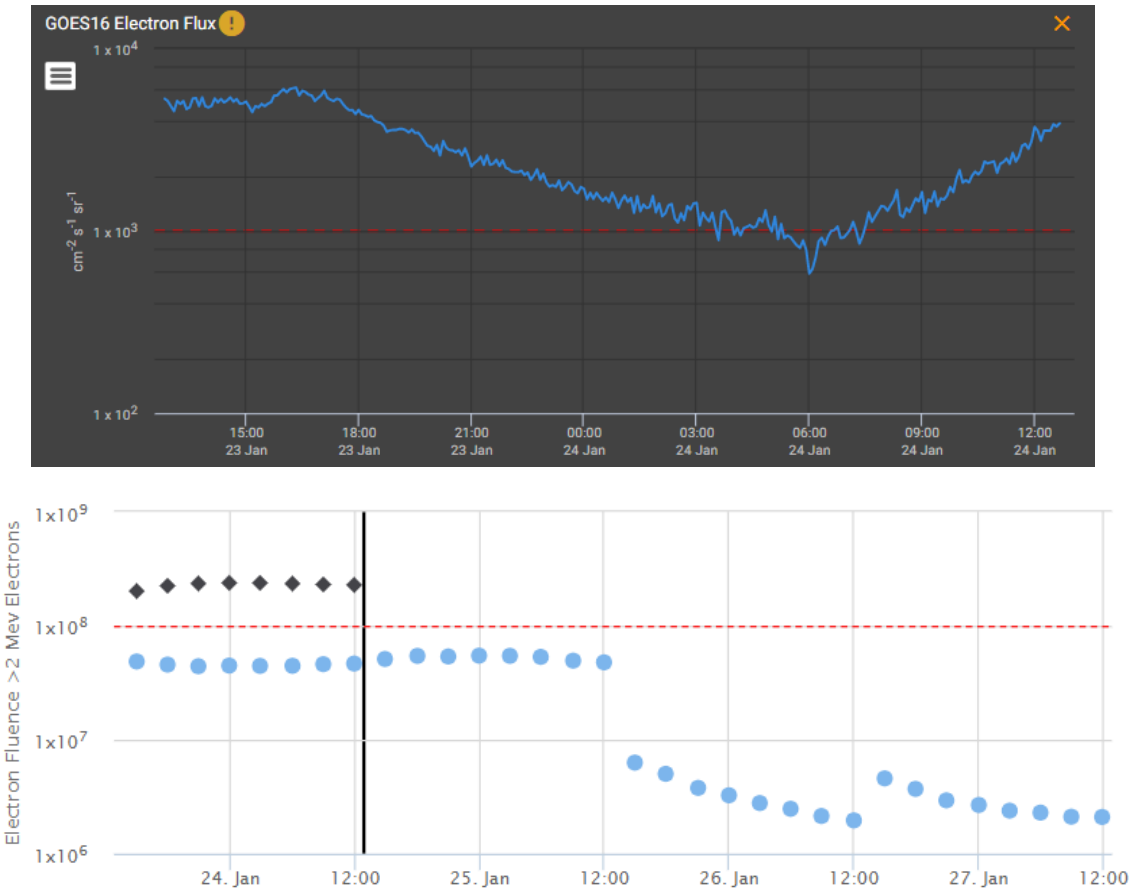
Figure 4: GOES-16 >2MeV Electron flux (top) and Fluence with REFM (bottom)



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